Exploring the Relationship Between the CORS Program and Regional Real Time GNSS Networks

Richard Snay & Neil Weston
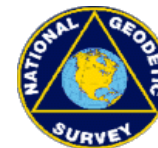NOAA's National Geodetic Survey

Gavin Schrock
Washington State Reference Network

Trimble's GPSNet User Group Meeting
Westminster, CO
May 9, 2006

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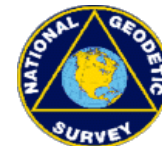
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Disclaimer

Material contained in this presentation represents ideas of a few individuals. Some of these ideas have yet to be adopted as official U.S. Government policy.

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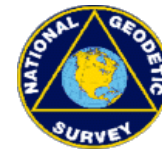
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Everyone is able to know where they are and
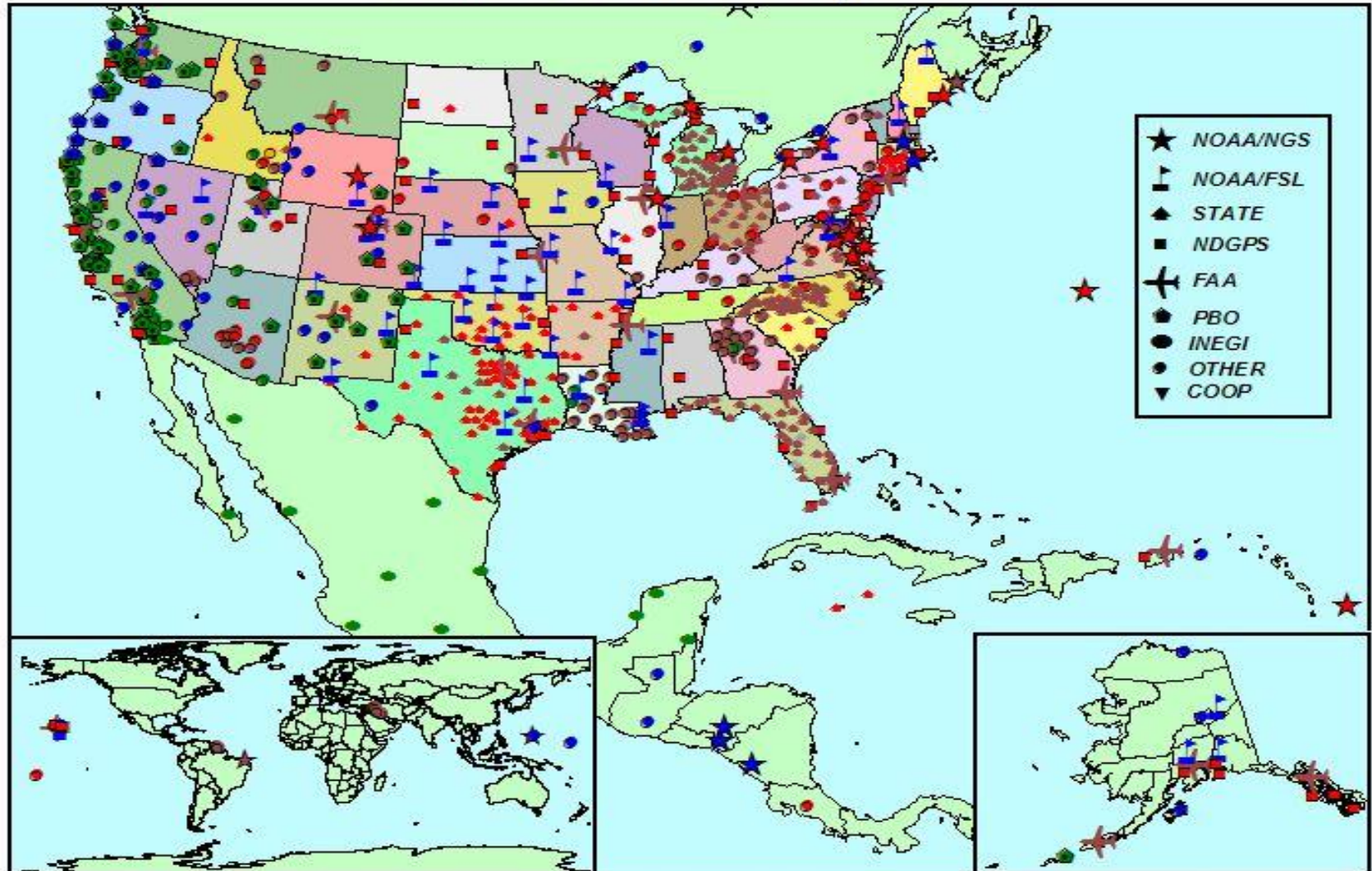

where other things are anytime, anyplace!

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Continuously Operating Reference Stations (CORS)

National CORS Network - April 2006

NOAA/NGS
NOAA/FSL
STATE
NDGPS
FAA
PBO
INEGI
OTHER
COOP

Symbol color denotes sampling rates: (1 sec) (5 sec) (10 sec) (15 sec) (30 sec) (Decommissioned)
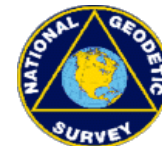
Craig 4/13/2006

CORS OVERVIEW

- Network contained 920+ sites as of Apr 2006

- Growing at rate of 15 sites per month

- More than 175 organizations participate in the CORS program

- Provides code range (C/A, P1, P2)

  – and carrier phase observations (L1, L2)

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CORS APPLICATIONS

- Postmission Static Positioning (cm-level accuracy with a few hours of data, dm-level accuracy with one minute of data)

- Postmission Kinematic Positioning (dm-level accuracy for an aircraft, a boat, or a land vehicle)

- Geophysics / Crustal Motion

- Meteorology / Water Vapor in Atmosphere
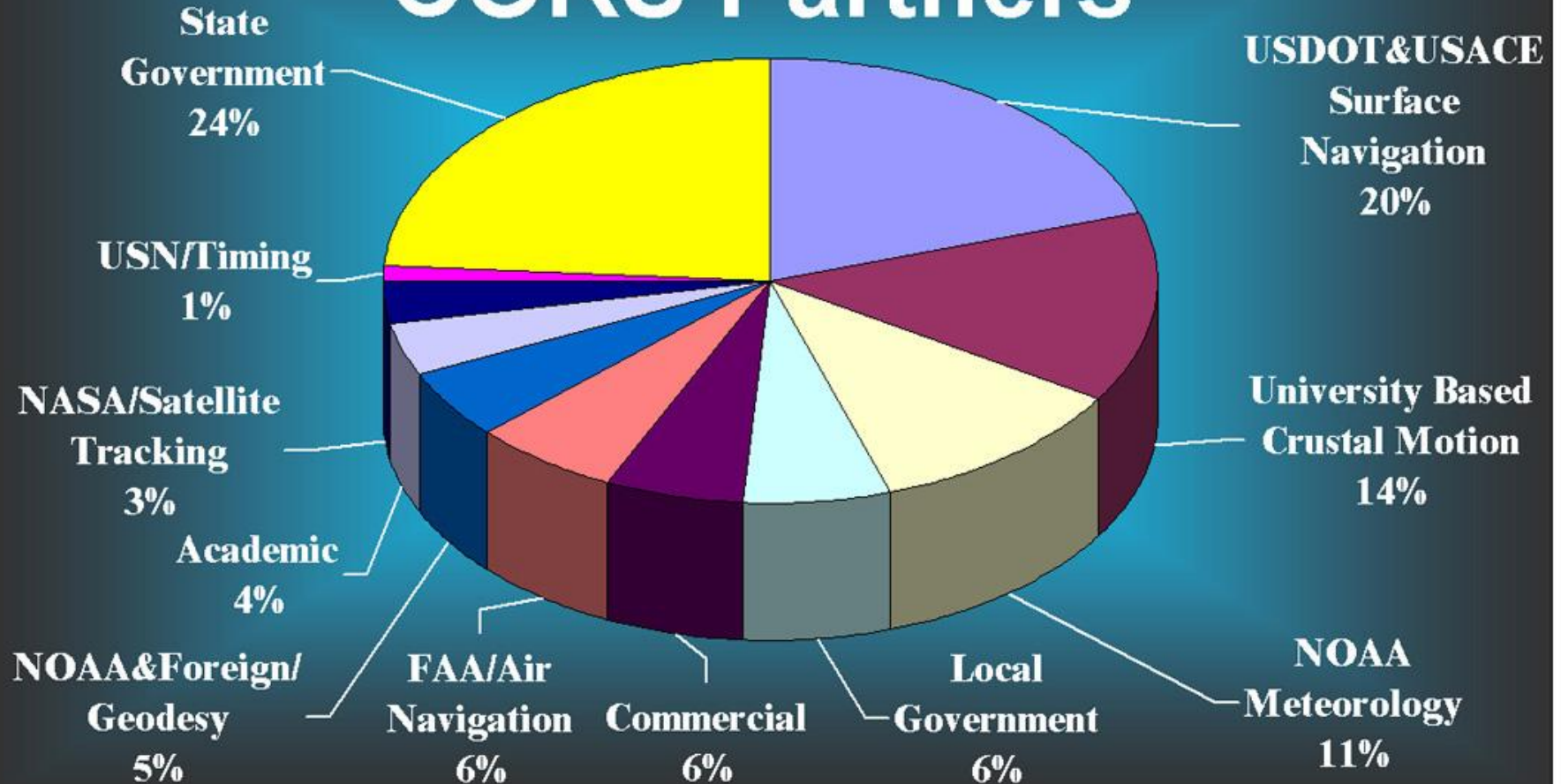
- Space Weather / Free Electrons in Ionosphere

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CORS Partners

- State Government 24%
- USDOT&USACE Surface Navigation 20%
- USN/Timing 1%
- NASA/Satellite Tracking 3%
- Academic 4%
- University Based Crustal Motion 14%
- NOAA&Foreign/Geodesy 5%
- FAA/Air Navigation 6%
- Commercial 6%
- Local Government 6%
- NOAA Meteorology 11%

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CORS Partners: Private Industry

" If you want to see where GPS is going, then keep your eye on the GPS manufacturers."
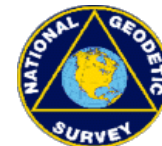Bill Strange
Former Manager
National CORS Program

Many GPS companies have developed software that provides their customers with automatic access to CORS data for postprocessing activities.
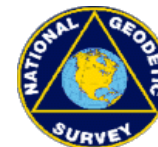
Real-Time Mantra

Pass the positions, NOW!!

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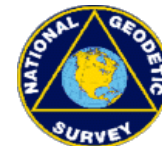
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Applications for 1- 5 cm Real-Time Positioning

- Land surveying

- Remote sensing / photogrammetry

- Hydrography

- Machine control (construction, precision agriculture)

- Emergency response

- Asset inventory

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Real-Time Applications (continued)

- Structural integrity monitoring (dams, bridges, critical facilities)

- Atmospheric monitoring (ionospheric & tropospheric modeling, weather forecasting)

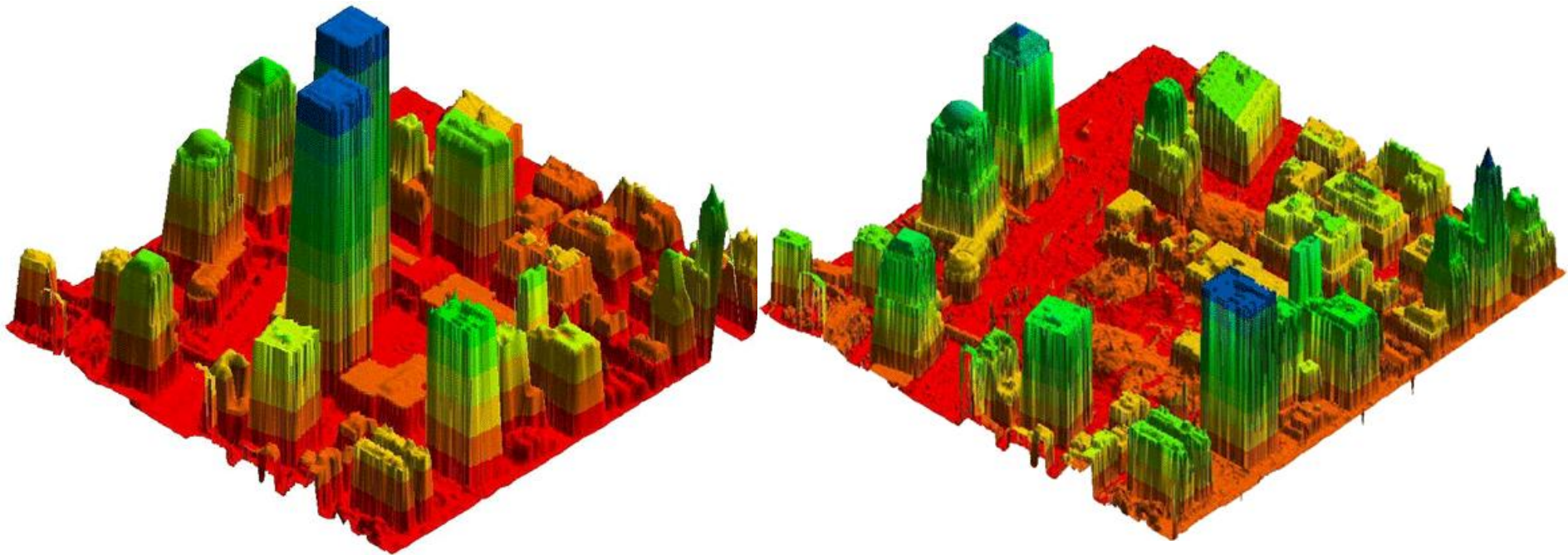- Tsunami & volcanic warning system (detecting seismic waves)

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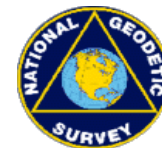
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LIDAR images of Manhattan before and after 11 SEP 2001

These images are computerized visualizations of elevation information of the World Trade Center from before (July 2000) and after (September 15, 2001) the attack. These maps were produced using an airborne LIDAR (Light Detection and Ranging) system. The LIDAR system creates detailed and highly accurate elevation information by the precise timing of thousands of laser pulses striking the ground surface. These data can be manipulated in the digital environment to create an array of maps and views of the project site and to obtain precise measurements of structures, debris fields, and other vital information. These images were generated by EarthData (www.earthdata.com), and the aircraft was positioned using CORS data from the NJI2 site which is operated by the New Jersey Institute of Technology.
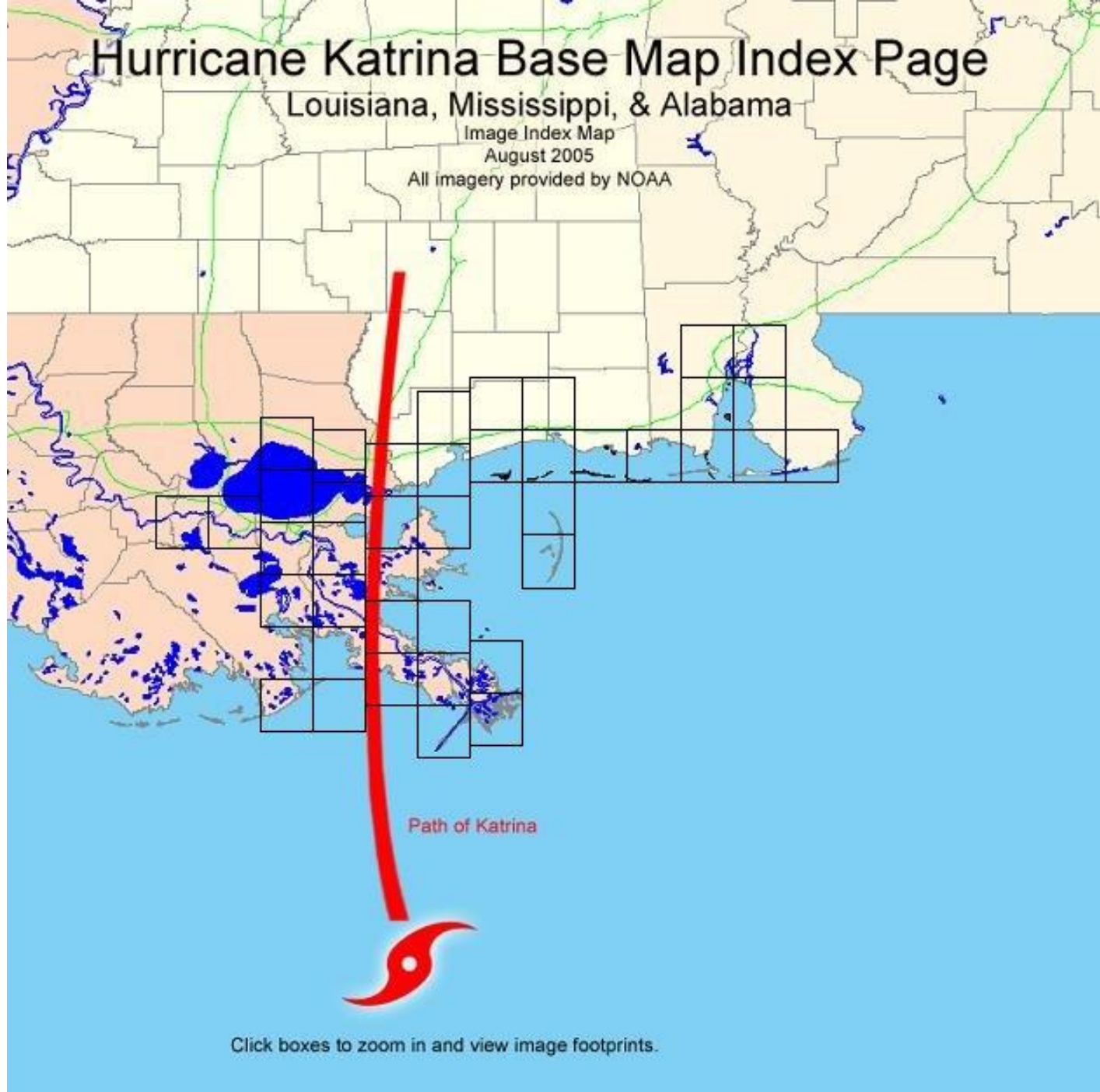
Hurricane Katrina Base Map Index Page

Louisiana, Mississippi, & Alabama

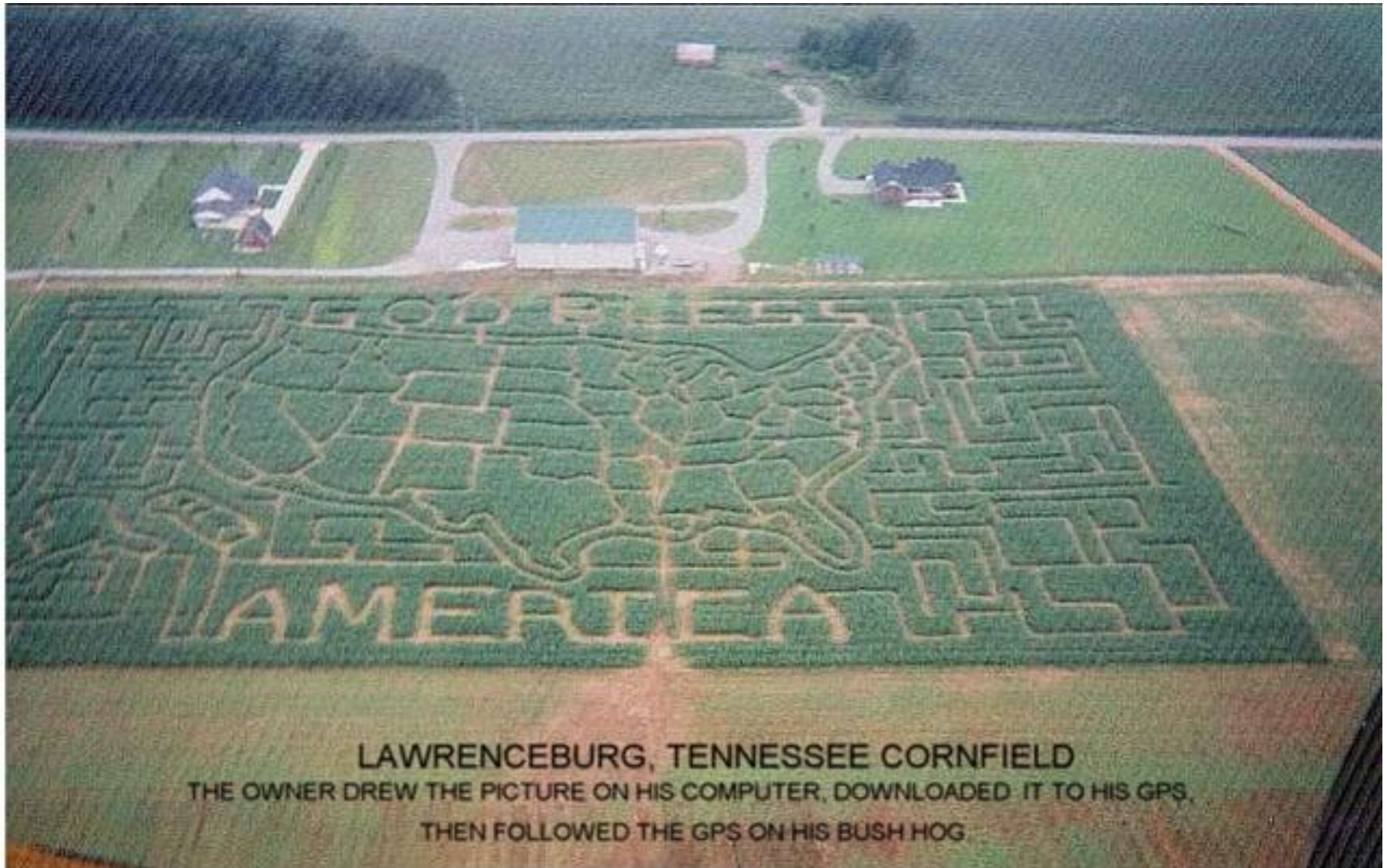Image Index Map
August 2005
All imagery provided by NOAA

Path of Katrina

Click boxes to zoom in and view image footprints.

Precision Agriculture

LAWRENCEBURG, TENNESSEE CORNFIELD
THE OWNER DREW THE PICTURE ON HIS COMPUTER, DOWNLOADED IT TO HIS GPS,
THEN FOLLOWED THE GPS ON HIS BUSH HOG

Hourly Forecast of Precipitable Water
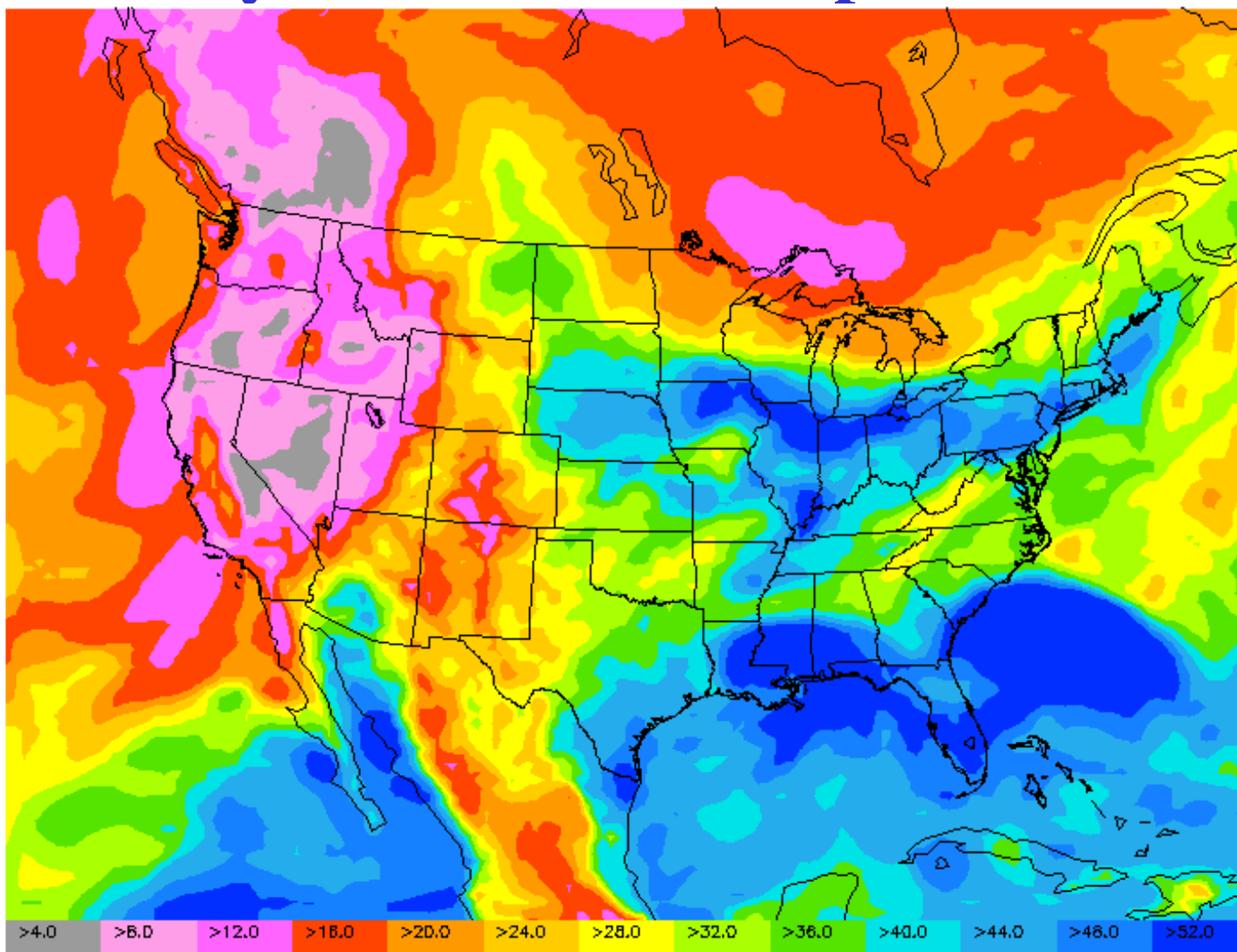
Precipitable water (mm)

Analysis valid 05-Aug-02 16:00Z

>4.0	>8.0	>12.0	>16.0	>20.0	>24.0	>28.0	>32.0	>36.0	>40.0	>44.0	>48.0	>52.0

NOAA/NGS Support for Regional Real-Time Networks

- Defining and providing access to the National Spatial Reference System (sanctioning adopted positional coordinates, velocities)

- Developing standards and guidelines

- Coordinating activities of the various regional networks (promote compatibility)

- Accrediting the various regional networks (monument stability, multipath environment)

- Assessing performance (monitoring data quality)

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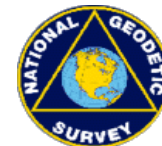
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NOAA/NGS Support for Regional Real-Time Networks

- Collect, archive, and distribute selected GNSS data from regional real-time networks to support post-processing applications (Also, encourage network operators to do likewise)

- That is, NOAA/NGS would incorporate selected real-time sites into the traditional CORS network

- NOAA/NGS would NOT rebroadcast the GNSS data from regional networks in real time

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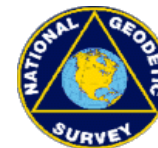
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NOAA/NGS Support for Regional Real Time Networks

- NOAA/NGS would publicly stream GNSS data (not correctors) via the Internet for ~ 200 federally-funded sites

- These sites may include elements of the NDGPS, WAAS, NOAA, and PBO networks

- Anticipated intersite spacing = 200 km in CONUS

- Regional real-time networks may use the NOAA/NGS-provided data to calibrate and/or enhance their services (which typically require an intersite spacing of about 50 km)

- If NOAA/NGS is to understand the intricacies of providing real-time data, then the agency needs to be intimately involved in the process

- These data are being federally funded (for other purposes), and they should be made publicly available for accurate real time positioning

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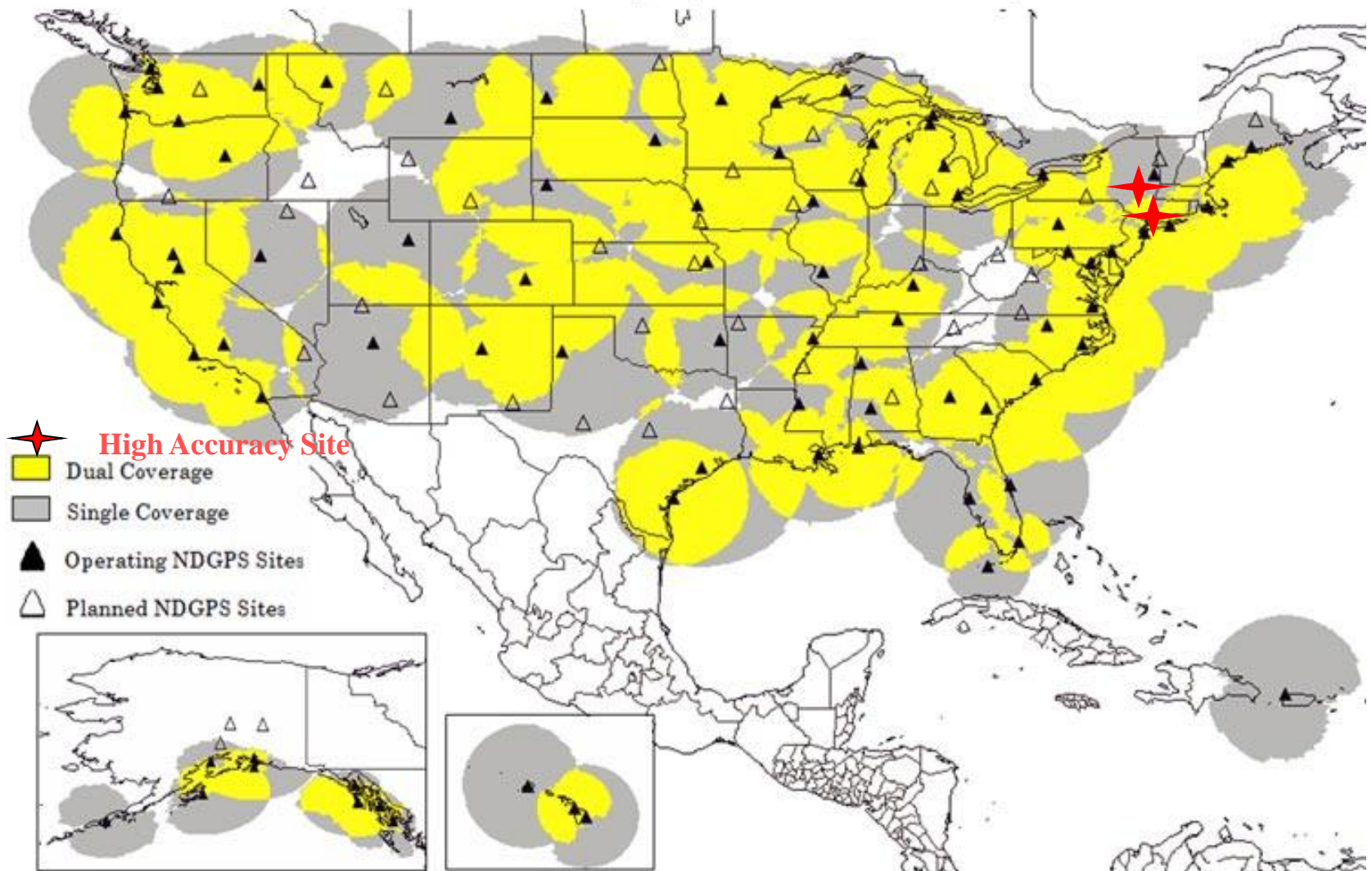
National Geodetic Survey
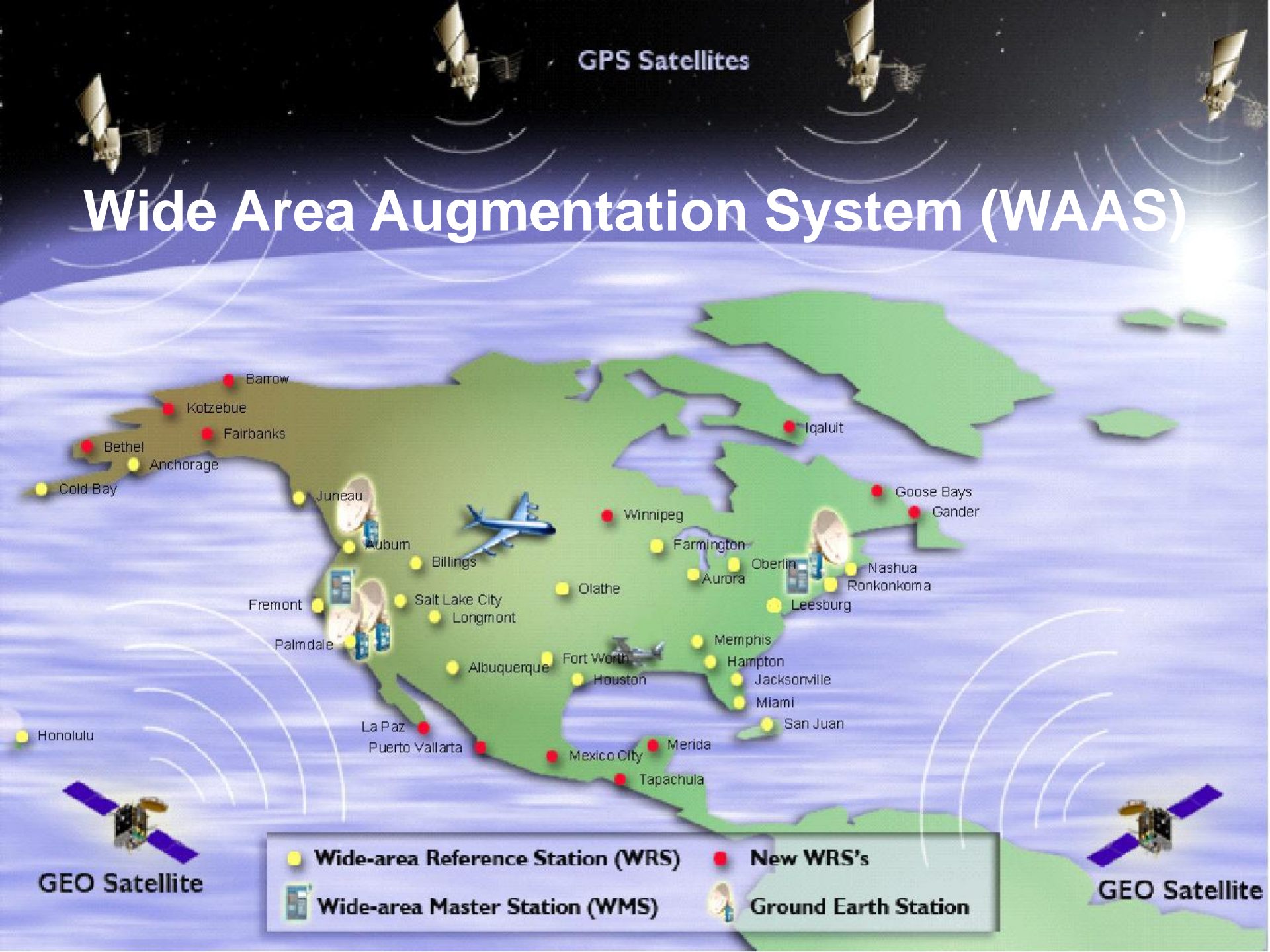
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Nationwide Differential GPS Network

NDGPS Coverage (03 NOVEMBER 2004)

★ High Accuracy Site
◼ Dual Coverage
◻ Single Coverage
▲ Operating NDGPS Sites
△ Planned NDGPS Sites

Wide Area Augmentation System (WAAS)

GPS Satellites

Barrow
Kotzebue
Fairbanks
Bethel
Anchorage
Cold Bay
Juneau
Auburn
Billings
Fremont
Salt Lake City
Longmont
Palmdale
Albuquerque
La Paz
Puerto Vallarta
Honolulu
Iqaluit
Goose Bays
Gander
Winnipeg
Farmington
Oberlin
Nashua
Aurora
Ronkonkoma
Olathe
Leesburg
Memphis
Hampton
Fort Worth
Jacksonville
Houston
Miami
San Juan
Mexico City
Merida
Tapachula

GEO Satellite

GEO Satellite

Wide-area Reference Station (WRS) • New WRS's
Wide-area Master Station (WMS) Ground Earth Station

Plate Boundary Observatory

PBO Network
- Existing GPS
- Backbone
- GSN Backbone
- Volcanoes
- New Cluster GPS

NOAA/NGS Support for Regional Real-Time Networks

NOAA/NGS would stream auxiliary information to the public via the Internet:

- Satellite ephemerides
- Satellite clock parameters
- Ionospheric models
- Tropospheric models

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NOAA/NGS Support for Regional Real-Time Networks

- NOAA/NGS would study temporal variations in positions (seasonal, daily, ocean loading, atmospheric loading, subsidence, tectonic, etc.)

- NOAA/NGS would study phenomena affecting accurate positioning (satellite orbits, refraction, multipath, antenna calibration, geoid, etc.)
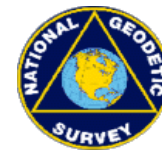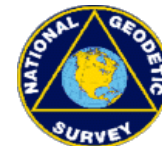
Not a Navigation Service

- It is important to realize that the regional real-time networks would not constitute a "navigation service" as defined by the U.S. Government, nor would the NOAA/NGS network. That is, these networks would not meet all "safety-of-life" requirements.

- These networks, however, would complement rigorous navigation services, such as the NDGPS and WAAS programs, by providing a 1 – 5 cm real-time positioning capability.

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A Special Application of Real-Time Data to Postprocessing

Immediately after a person has collected a couple hours of GNSS data at a single location, this person could submit these data to OPUS to obtain highly accurate positional coordinates for his/her location in minutes. This capability assumes the person has Internet access and that NGS receives a real-time data feed from a few CORS located near to the person's location.

Benefit: the person would know whether or not he/she observed suitable data before leaving the location.

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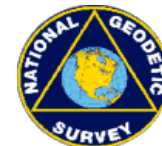National Ocean Service

National Geodetic Survey
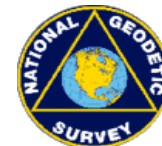
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NOAA/NGS Goal for Real-Time Positioning

Promote accurate and reliable real-time positioning services that are consistent with the National Spatial Reference System, whether these services are being provided by a public or commercial organization.

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